Amendments to the Claims:

The following claims will replace all prior versions of the claims in this application (in the unlikely event that no claims follow herein, the previously pending claims will remain):

1. (Original) An adaptive RAKE receiving apparatus constrained with at least one constraint in a mobile communication system, the apparatus comprising:

input signal generating means for generating a complex received signal by gathering multi-path components during a corresponding transmitting signature;

adaptive filtering means for filtering the complex received signal based on a tab weight that is adjusted at a predetermined period;

channel estimating means for estimating a phase component and an amplitude component of a particular user channel by using the filtered signal from the adaptive filtering means to generate a channel estimating result signal;

signal recovering means for recovering an original signal, which was transmitted from a particular user, by combining the filtered signals from the adaptive filter means for all multi-path components and the channel estimating result signal from the channel estimating means;

selecting means for selecting one between a predetermined trained data signal and the recovered signal from the signal recovering means;

reference signal generating means for generating a reference signal by using the selected signal from the selecting means and the channel estimation result signal from the channel estimating means;

error calculating means for comparing the filtered received signal from the adaptive filtering means with the reference signal from the reference signal generating means to calculate error between these compared two signals; and

tap coefficient adjusting means for adjusting tap coefficients of the adaptive filtering means based on MMSE (Minimum Mean Square Error) criterion with at least one constraint (constraint MMSE criterion).

2. (Original) The receiver as recited in claim 1, wherein the constraint MMSE criterion is defined as:

$$J \equiv E\left[\left|\hat{c}_l(n)d_1(n) - \mathbf{w}_l(n)^H \mathbf{r}_l(n)\right|^2\right] \text{ subject to } \mathbf{w}_l(n)^H \mathbf{s}_1 = 1$$

where J is the constraint MMSE criterion, E represents a mean value, $\hat{c}_l(n)$ is an estimated channel for the l-th multi-path component, $d_1(n)$ is the selected signal from the

selecting means, $\mathbf{w}_l(n)$ is an adaptive filter coefficient vector, and a superscript H represents Hermitian operation, and

a product of the tap coefficient $w_l(n)$ of the adaptive filtering means and a spread code vector $\mathbf{s}_1$ is constrained to be substantially 1 so that the error calculated at the error calculating means is minimized.

3. (Original) The receiver as recited in claim 2, wherein the tap coefficient of the adaptive filtering means for the l-th multi-path component is orthogonal-separated into a spreading code vector and an adaptive component orthogonal to the spreading code vector expressed as:

$$\mathbf{w}_l(n) = \mathbf{s}_1 + \mathbf{x}_l(n)$$

where $\mathbf{s}_1$ is the spreading code vector and $\mathbf{x}_l(n)$ is the adaptive component of the tap coefficient vector, these two vectors being orthogonal to each other,

the adaptive component orthogonal to the spreading code vector is changed by using a component of the received signal, which is projected into the adaptive component orthogonal to the spreading code vector rather than using directly the received signal.

4. (Original) The receiver as recited in claim 1, wherein the constraint MMSE criterion is defined as:

$$J \equiv E\left[\left|\hat{v}_l(n)d_1(n) - \mathbf{w}_l(n)^H \mathbf{r}(n)\right|^2\right] \text{ subject to } \mathbf{w}_l(n) = \mathbf{u}_{1l} + \mathbf{z}_l(n)$$

$$\text{and } \mathbf{z}_l(n) \perp Range(\mathbf{U})$$

where J is the constraint MMSE criterion, E represents a mean value, $\hat{c}_l(n)$ is an estimated channel for the l-th multi-path component, $d_1(n)$ is the output signal from the selecting means, $\mathbf{w}_l(n)$ is an adaptive filter coefficient vector, and a superscript H represents Hermitian operation,

the inner product of the tap coefficient $\mathbf{w}_l(n)$ of the adaptive filtering means for the l-th multi-path component and the spreading code vector $\mathbf{s}_{1l}$ for the corresponding multi-path component is constrained to be substantially 1 and the inner product of the tap coefficient $\mathbf{w}_l(n)$ of the adaptive filtering means for the l-th multi-path component and the spreading code vector $\mathbf{s}_{1l}$ ($l \neq 1$) for other corresponding multi-path component is constrained to be substantially 0 so that the error that is calculated by the error calculating means is minimized.

5. (Original) The receiver as recited in claim 4, wherein the tap coefficient of the adaptive filter means for the l-th multi-path component is orthogonal-separated into a spreading code vector and an adaptive component orthogonal to the spreading code vector as:

$$\mathbf{w}_l(n) = \overline{\mathbf{s}}_{1l} + \mathbf{x}_l(n)$$

where $\overline{\mathbf{s}}_{1l} = \mathbf{S}(\mathbf{S}^H\mathbf{S})^{-1}\mathbf{f}_l$, $\mathbf{f}_l$ is a L-by-1 column vector with all elements 0's except 1 at the l-th position and $\mathbf{x}_l(n)$ is the adaptive component of the tap coefficient vector, $\mathbf{x}_l(n)$ being orthogonal to a range spanned by S, i.e., $\mathbf{x}_l(n) \perp Range(\mathbf{S})$,

the adaptive component orthogonal to the spreading code vector is changed by using a component of the received signal, which is projected into the adaptive component orthogonal to the spreading code vector rather than using directly the received signal.

6. (Original) The receiver as recited in claim 2, wherein the constraint MMSE criterion for updating the coefficient of the adaptive filtering means for the l-th multi-path component is implemented by orthogonal separation LMS (least mean square) algorithm as:

$$\mathbf{x}_l(n+1) = \mathbf{x}_l(n) + \mu \cdot e_l(n)^* \cdot \mathbf{P}_{\mathbf{S}}^{\perp}\mathbf{r}(n)$$

where $e_l(n) \equiv \hat{c}_l(n)d_1(n) - \mathbf{w}_l(n)^H\mathbf{r}(n)$, i.e., the difference between the product of the channel estimation value and data and the output of the adaptive filtering means, and $\mathbf{P}_{\mathbf{S}}^{\perp} = \mathbf{I} - \mathbf{S}(\mathbf{S}^H\mathbf{S})^{-1}\mathbf{S}^H$, $\mathbf{P}_{\mathbf{S}}^{\perp}\mathbf{r}(n)$ being a component of $\mathbf{r}(n)$ projected into $\mathbf{x}_l(n)$, μ is a step size that determines the rate at which the tap coefficient changes, and a superscript * represents complex conjugate operation.

7. (Original) The receiver as recited in claim 1, wherein, in order to estimate the channel for the l-th multi-path component, the channel estimating means multiplies the outputs of the adaptive filtering means for the multi-path components with the complex conjugate of data for a predetermined number of the pilot symbol and averages the multiplied results as follows:

$$\hat{c}_l = \frac{1}{N_p}\sum_{i=1}^{N_p} b_1^*(n-iQ)\mathbf{w}_l^H(n-iQ)\mathbf{r}_l(n-iQ)$$

where N_p is the number of the pilot symbols used for the channel estimation and Q is an inserting period of the pilot symbol.

8. (Original) The receiver as recited in claim 1, where the constraint MMSE criterion is defined as:

$$J \equiv E\left[\left|\hat{v}_l(n)d_1(n) - \mathbf{w}_l(n)^H \mathbf{r}(n)\right|^2\right] \text{ subject to } \mathbf{w}_l(n) = \mathbf{u}_{1l} + \mathbf{z}_l(n)$$

$$\text{and } \mathbf{z}_l(n) \perp Range(\mathbf{U})$$

where J is the constraint MMSE criterion, E represents a mean value, $\hat{v}_l(n)$ is a coefficient estimated by the l-th basis component, $d_l(n)$ is the output of the selected means, $\mathbf{z}_l(n)$ is a variable component of an adaptive filter coefficient, $\mathbf{r}(n)$ is an adaptive filter input signal vector, $\mathbf{U} = [\mathbf{u}_{11} \quad \mathbf{u}_{12} \quad \ldots \quad \mathbf{u}_{1L}]$ is a matrix constructed by L left singular vectors of $\mathbf{S} = [\mathbf{s}_{11} \quad \mathbf{s}_{12} \quad \cdots \quad \mathbf{s}_{1L}]$ and a superscript H represents Hermitian operation,

the inner product of the tap coefficient $\mathbf{w}_l(n)$ of the adaptive filtering means for the l-th multi-path component and the spreading code vector $\mathbf{s}_{1l}$ for the corresponding multi-path component is constrained to be substantially 1 and the inner product of the tap coefficient $\mathbf{w}_l(n)$ of the adaptive filtering means for the l-th multi-path component and the spreading code vector s_{1l} (l$\neq$1) for other multi-path components is constrained to be substantially 0 so that the error that is calculated by the error calculating means is minimized.

9. (Original) The receiver as recited in claim 8, wherein the tap coefficient of the adaptive filtering means for the l-th multi-path component is orthogonal-separated into a spreading code vector and an adaptive component orthogonal to the spreading code vector as:

$$\mathbf{w}_l(n) = \mathbf{u}_{1l} + \mathbf{z}_l(n)$$

where $\mathbf{u}_{1l}$ is the l-th left singular vector of the spreading code matrix $\mathbf{S}$ and $\mathbf{z}_l(n)$ is the adaptive component of the tap coefficient vector, $z_l(n)$ being orthogonal to the range spanned by $\mathbf{U}$, i.e., $\mathbf{z}_l(n) \perp Range(\mathbf{U})$,

the adaptive component orthogonal to the spreading code vector is changed by using a component of the received signal, which is projected into the adaptive component orthogonal to the spreading code vector rather than using directly the received signal.

10. (Original) The receiver as recited in claim 8, wherein the constraint MMSE criterion for updating the coefficient of the adaptive filtering means for the l-th multi-path component is implemented by orthogonal separation LMS (least mean algorithm) expressed as:

$$\mathbf{z}_l(n+1) = \mathbf{z}_l(n) + \mu \cdot e_l(n)^* \cdot \mathbf{P}_{\mathbf{U}}^{\perp}\mathbf{r}(n)$$

where $e_l(n) \equiv \hat{v}_l(n)d_1(n) - \mathbf{w}_l(n)^H \mathbf{r}(n)$, i.e., the difference between the product of the channel estimation and data and the output of the adaptive filtering means, $\mathbf{P}_{\mathbf{U}}^{\perp} = \mathbf{I} - \mathbf{U}(\mathbf{U}^H\mathbf{U})^{-1}\mathbf{U}^H = \mathbf{I} - \mathbf{U}\mathbf{U}^H$, $\mathbf{P}_{\mathbf{U}}^{\perp}\mathbf{r}(n)$ is a component of $\mathbf{r}(n)$ projected to $z_l(n)$, μ is a step size that is a rate at which the tap coefficient is changed, and a superscript * represents complex conjugate operation.

11. (Original) The receiver as recited in claim 1, wherein, in order to estimate the channel for the l-th multi-path component, the channel estimating means multiplies the outputs of the adaptive filtering means for the multi-path components with the complex conjugate of data for a predetermined number of the pilot symbol and averages the multiplied values by an equation expressed as:

$$\hat{v}_l = \frac{1}{N_p}\sum_{i=1}^{N_p} b_1^*(n-iQ)\mathbf{w}_l^H(n-iQ)\mathbf{r}(n-iQ)$$

where N_p is the number of the pilot symbols used for the channel estimation and Q is an inserting period of the pilot symbol.

12. (Original) The receiver as recited in claim 1, wherein the channel estimating means estimates the channels for all of the multi-path components by using the outputs of the adaptive filtering means, and the output of the selecting means for the predetermined number of the pilot symbols expressed as:

$$\begin{bmatrix} \hat{c}_1(n) \\ \vdots \\ \hat{c}_L(n) \end{bmatrix} = \begin{bmatrix} 1 & \mathbf{w}_1^H(n)\mathbf{s}_1(\tau_2-\tau_1) & \cdots & \mathbf{w}_1^H(n)\mathbf{s}_1(\tau_L-\tau_1) \\ \vdots & \vdots & \vdots & \vdots \\ \mathbf{w}_L^H(n)\mathbf{s}_1(\tau_1-\tau_L) & \mathbf{w}_L^H(n)\mathbf{s}_1(\tau_2-\tau_L) & \cdots & 1 \end{bmatrix}^{-1} \cdot \begin{bmatrix} b_1^*(n)\mathbf{w}_1^H(n)\mathbf{r}_1(n) \\ \vdots \\ b_1^*(n)\mathbf{w}_L^H(n)\mathbf{r}_L(n) \end{bmatrix}$$

where $\mathbf{s}_1(p)$ is a p chip-shifted version of $\mathbf{s}_1 = [s_{11} \quad s_{12} \quad \ldots \quad s_{1,N-1} \quad s_{1,N}]^T$ that is a normalized spreading code for the first user, p being an arbitrary integer, if p is a positive integer, $\mathbf{s}_1(p) = [\mathbf{0}_p \quad s_{11} \quad s_{12} \quad \cdots \quad s_{1,N-p}]^T$ and if p is a negative integer, $\mathbf{s}_1(p) = [s_{1,-p+1} \quad s_{1,-p+2} \quad \cdots \quad s_{1,N} \quad \mathbf{0}_p]^T$, $\mathbf{0}_p$ being a 1xp 0 vector, $(\tau_i - \tau_l)$ being the

transmission delay difference between the i-th multi-path component and the l-th multi-path component, which is integer times of a chip.

13. (Original) An adaptive RAKE receiving method using at least one constraint in a mobile communication system, the method comprising the steps of:

(a) setting initial coefficients of adaptive filters for multi-path components;

(b) providing each of the adaptive filters with a corresponding multi-path component of a user to perform complex signal filtering;

(c) deciding a channel estimation value for the multi-path component;

(d) generating a reference signal by determining a transmitted data;

(e) calculating an error between the reference signal and the filtered received signal; and

(f) updating the coefficient of the adaptive filters based on a constraint MMSE criterion.

14. (Original) The method as recited in claim 13, wherein the step (b) includes the steps of:

(g) gathering each of the multi-path components corresponding to the transmitted signature to provide them to each of the adaptive filters; and

(h) filtering the complex received signal by using the input of the adaptive filter and the coefficient of the adaptive filter.

15. (Original) The method as recited in claim 14, wherein the step (b) includes the step of:

(i) compensating transmission delays of the multi-path components and gathering the compensated received signals to provide them to each of the adaptive filters.

16. (Original) The method as recited in claim 14, wherein the step (g) includes the step of:

(i) gathering the received signal corresponding to period from a starting chip of a transmitted symbol of the firstly received multi-path component among the multi-path components to a final chip of the transmitted symbol of a last received multi-path component among the multi-path components to provide the gathered signals to each of the adaptive filters.

17. (Currently Amended) The method as recited in claim 13, wherein the step (c) includes the steps of:

(j) estimating the channel for each of the multi-path components by using ~~the~~ a pilot symbol; and

(k) multiplying the complex conjugate value of each of the estimated channel value with the output of the adaptive filter for the corresponding multi-path component, and summing up the multiplied values for all of the multi-path components to decide channel estimation value for the transmitted signal.

18. (Currently Amended) The method as recited in claim 17, wherein the step (j) includes the step of:

(l) estimating the channel by maximum likelihood combination by using the outputs of the adaptive filters for all the multi-path components and the output of ~~the~~ a selecting means.

19. (Original) The method as recited in claim 13, wherein the step (d) includes the step of:

(m) deciding a transmitted data; and

(n) generating a reference signal by using the decided data and the channel value.

20. (Original) A computer readable recording medium for recording a program for implementing in mobile communication system for providing with an adaptive RAKE receiving apparatus constrained with at least one constraint and having a microprocessor, the functions of:

(a) setting initial coefficients of adaptive filters for multi-path components;

(b) providing each of the adaptive filters with a corresponding multi-path component of a user to perform complex signal filtering;

(c) determining a channel estimation value for the multi-path component;

(d) generating a reference signal by determining a transmitted data;

(e) calculating an error between the reference signal and the filtered received signal; and

(f) updating the coefficient of the adaptive filters based on a constraint MMSE criterion.